

## Original Article

# Surgical Treatments in Inferior Oblique Muscle Overaction

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### Abstract

**Purpose:** To compare the outcomes of surgical procedures in the treatment of inferior oblique muscle overaction (IOOA) as a common disorder of ocular motility.

**Methods:** This retrospective study was performed on patients with primary and secondary IOOA who underwent three surgical treatment procedures including disinsertion, myectomy and anterior transposition, between 2001 and 2011. Type of strabismus, ocular alignment, presence of pre- and post-operative dissociated vertical deviation (DVD), pre- and post-operative degree of IOOA were obtained using specified checklist.

**Results:** A total of 122 eyes of 74 patients with mean age of  $13 \pm 11.7$  (range, 1-51) years were included in this study. Disinsertion was performed on 12 eyes (9.8%), myectomy in 91 eyes (74.6%) and anterior transposition in 19 (15.6%). Preoperative V-pattern and DVD existed in 67 and 17 eyes; after surgery they remained in only 10 and 8 eyes, respectively. The success rate (IOOA <+1), in disinsertion, myectomy and anterior transposition groups were 91.7%, 97.8%, and 89.5%, respectively and these measures did not change after 6 months. Overall, 53.3% ( $n = 65$ ) and 38.5% ( $n = 47$ ) of eyes had preoperative esotropia and exotropia. Preoperative hypertropia and hypotropia were observed in 16.4% ( $n = 20$ ) and 3.3% ( $n = 4$ ) of eyes, respectively. After surgery there were no cases of additional strabismus. However, residual hypertropia was seen in 9 eyes, while preoperative hypotropia increased in one patient who underwent anterior transposition surgery. Esotropia and exotropia were not observed in any surgical treatment groups postoperatively.

**Conclusion:** We conclude that all these three procedures are effective for treatment of primary or secondary IOOA with minimum side-effects.

**Keywords:** Anterior Transposition; Disinsertion; Inferior Oblique Muscle Overaction; Myectomy

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### INTRODUCTION

Excessive elevation of the eyeball in intended adduction is a consequence of inferior oblique muscle over action (IOOA), which is a common disorder of ocular motility<sup>[1]</sup> and is reported in 70% of patients with esotropia and 30% of patients with exotropia.<sup>[2]</sup> These two conditions may coexist with A-pattern and V-pattern

occurring due to dysfunction of oblique muscle.<sup>[3]</sup> When the major cause of A- and V-patterns are dysfunction of oblique muscle, surgical treatment is recommended.<sup>[2,4]</sup>

There are two types of IOOA, the primary type which is bilateral of unknown cause, usually results in infantile esotropia appearing after the first year of birth.<sup>[5]</sup> The secondary type, in contrast, is unilateral and is

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caused by paresis or paralysis of the superior oblique muscle.<sup>[6]</sup> Several techniques are used for surgical correction of IOOA including disinsertion, extirpation and denervation, recession, myectomy and anterior transposition of IO muscle.<sup>[7-10]</sup>

The weakening procedures of IO muscle spread since White and Brown reported IO disinsertion in the 1930s. Currently, myectomy of the IO and IO recession are the most widely used procedures to treat IOOA. Anterior transposition of IO is another procedure for correcting IOOA. This procedure is efficient for treatment of IOOA with coexisting dissociated vertical deviation (DVD).<sup>[8,11]</sup>

Although several studies investigated the superiority of these operations, but none of them are the procedure of choice for IOOA correction. While retrospective studies show similarity of anterior transposition and myectomy for treatment of IOOA,<sup>[12]</sup> prospective studies indicate that anterior transposition is more effective in reduction of IOOA.<sup>[13]</sup> In addition, a randomized controlled trial (RCT) disproved any difference between myectomy and recession of IO.<sup>[14]</sup> Due to conflicts between these studies, we compared three of these procedures performed at our center including disinsertion, myectomy and anterior transposition of the IO muscle through a retrospective study.

## METHODS

This retrospective study was performed on consecutive patients with IOOA who underwent surgical treatment at the Ophthalmology Department of Rassoul Akaram Hospital, a Tertiary Care Center in Tehran, between 2001 and 2011. All surgeries were done by attending ophthalmologists. All patients with IOOA who underwent first surgical treatment were included in this study. The surgical procedures included disinsertion, myectomy and anterior transposition of IO muscle by standard methods. The type of surgery was determined according to surgeon's preference. Patients were excluded if had prior ocular disease or surgery, restrictive strabismus, history of trauma and neurologic, genetic or craniofacial abnormalities.

The study design was approved by Institutional Review Board of Iran University of Medical Sciences. The survey was conducted in agreement with the declaration of Helsinki.

### Surgical Technique

In all techniques, the IO muscle was approached through the conjunctiva and Tenon's capsule by an inferior-temporal fornix incision. Later, the lateral rectus muscle was isolated by means of a 4-0 silk bridle suture. Using muscle hooks, the IO muscle was isolated from its fascial attachments both anteriorly and posteriorly.

In myectomy, two hemostats are used, and a space of 5 mm or more was maintained between the hemostats and hence; the segment of muscle between the hemostats was resected. Cautery, ligature, or both are used for hemostasis. Disinsertion occurs at the scleral attachment of the IO muscle. In anterior transposition, The IO muscle is placed just anterior and temporal to the insertion of inferior rectus muscle.

The follow-up period was 6 months. A complete history was taken.

Patients underwent full ocular and orthoptic examinations; ocular alignment in primary position, up-gaze and down-gaze were measured by a prism cover test before and after surgery.

DVD was measured using a prism and an alternate cover test in which the eyes, in primary position, are fixed at an adjustable target at a distance of 6 meters with full refractive corrections, when these are worn. Any concurrent horizontal deviation was neutralized using a horizontal prism. Subsequently, DVD in the other eye was measured in the same way. The preoperative and postoperative binocular alignment and motility assessment included alternate prism and cover measurements in the primary position at distance and near, and distant midline up-gaze and down-gaze. The function of the oblique muscles was studied by comparing the coordinated movement of the two eyes in cardinal fields of gaze, up and right, up and left, down and right, and down and left. Oblique muscle dysfunction was graded in approximately 45° adducted eye on a nine point scale from -4 underaction to +4 overaction. For this, the fixating abducted eye initially remained elevated approximately 30° above mid-level and was then lowered to approximately 30° below mid-level. The underactions and overactions of the oblique muscles were graded in approximately 7° increments.<sup>[13]</sup>

The records of all patients were reviewed and data were obtained using specified checklist. This checklist included patients' age, gender, type of strabismus, presence of pre-and post-operative DVD, pre-and post-operative degree of IOOA and type of surgical treatment. Checklists were filled by research staff and reviewed by project supervisor.

The success rate considered as IOOA <+1.

### Statistical Analysis

The statistical analyses were performed using SPSS software (version 16.0; SPSS, Inc. SPSS, Chicago, IL, USA). Data are reported as mean  $\pm$  standard deviation (SD) for continuous variables and as percentages for categorical variables. To evaluate preoperative and postoperative results, paired *t*-test was performed. Differences between the results of surgical treatment groups were tested using independent sample *t*-test and one-way analysis of variances.

## RESULTS

A total of 122 eyes of 74 patients were included in this study and preoperative, postoperative and 6 months follow-up data were recorded and analyzed. Mean age of patients was  $13 \pm 11.7$  (range, 1-51) years. Out of 122 eyes, 58 (47.5%) right eyes and 64 (52.5%) left eyes underwent surgery. Unilateral IOOA in 26 (21.3%) patients and bilateral IOOA in 48 (78.7%) subjects were observed. General characteristics of patients are shown in Table 1. The surgical treatment included disinsertion, which was performed on 12 (9.8%) eyes, myectomy in 91 (74.6%) and anterior transposition in 19 (15.6%) eyes. The mean age was not statistically significant among the three surgical treatment groups.

Pre- and post-operative eye conditions are shown in Table 2. Preoperative esotropia and exotropia were present in 53.3% ( $n = 65$ ) and 38.5% ( $n = 47$ ) of eyes and preoperative hypertropia and hypotropia were observed in 16.4% ( $n = 20$ ) and 3.3% ( $n = 4$ ) of eyes, respectively. In addition, 67 (54.9%) eyes presented with V-pattern and DVD was exhibited in 17 (13.9%) subjects, preoperatively.

After surgery there were no cases of additional strabismus and residual hypertropia (residual IOOA due to residual IO muscle fibers) was seen in 9 eyes, while preoperative hypotropia increased in one patient who underwent anterior transposition surgery. Esotropia and exotropia were not observed in any surgical treatment groups postoperatively and improved in all patients.

After the operation, V-pattern remained in only 10 patients with significantly lesser degrees and DVD persisted in 8 eyes of patients including 6 eyes in the myectomy group and 2 eyes in the anterior transposition group. While postoperative DVD improved in all patients in the disinsertion group, this difference was not statistically significant ( $P = 0.5$ ) [Table 2]. There was no IO muscle paralysis after surgery, but IO muscle underaction (IOUA), defined as elevation deficit in adduction with free force duction test, appeared in 4 eyes.

The success rate in the disinsertion, myectomy and anterior transposition groups were 91.7%, 97.8%, and 89.5%, respectively and these measures did not change after 6-months' follow up [Tables 3 and 4].

## DISCUSSION

Many studies have investigated the superiority of different surgical treatments for IOOA, however there are controversies in different studies. These procedures are tenotomy, extirpation and denervation, recession, myectomy and anterior transposition of IO muscle.<sup>[7-10]</sup> In the present retrospective study, there was no difference between disinsertion, myectomy and anterior transposition success rates. In addition, V-pattern and DVD improved in all patients. This study includes both pediatric and adult patients in which age ranged from 1 to 51 years.

Ghazawy et al investigated the efficacy of myectomy versus anterior transposition in a retrospective study. They showed that both procedures are effective in treatment of IOOA but myectomy is superior to anterior transposition for underaction of superior oblique muscle.<sup>[12]</sup> In a prospective comparison of anterior transposition and myectomy which was performed by Min et al on 20 children with bilateral 3+ IOOA, the success rate in anterior transposition group (85%) was much higher than myectomy group (25%).<sup>[13]</sup> Mulvihill et al performed a retrospective study on 52 patients with IOOA secondary to superior oblique paresis to examine the safety and efficacy of IO disinsertion. They concluded that this procedure is safe and effective for treatment of this type of IOOA.<sup>[15]</sup> Studies comparing disinsertion with other procedures such as myectomy and anterior transposition have been not performed yet.

In the current study, we did not include recession because it is not considered as a surgical treatment for IOOA in our hospital and it can be our study limitation. However, there are other studies comparing this procedure with myectomy and anterior transposition. In an RCT conducted by Rajavi et al,<sup>[14]</sup> both recession and myectomy had considerable effect on IOOA and although myectomy results in better correction of IOOA, the rate of underaction of IO muscle was higher in this group. Another study by Muchnick et al compared the efficacy of anterior transposition versus recession in IOOA associated with superior oblique paresis in which both procedures improved the hyperdeviation in the field of action of superior and IO muscle, similarly.<sup>[16]</sup>

Preoperative conditions such as esotropia and exotropia were not significantly different between

**Table 1. General characteristics of patients in surgical treatment groups**

	Disinsetion (%)	Myectomy (%)	Anterior transposition (%)	P value
Eye	12 (9.8)	91 (74.6)	19 (15.6)	
Age	$19.1 \pm 17.7$	$12.5 \pm 11.2$	$10.6 \pm 8.9$	0.126
Male	5 (4.09)	40 (32.8)	13 (10.6)	0.007
Female	7 (5.7%)	51 (41.8)	6 (4.9)	
Spherical equivalent (diopter)	$0.16 \pm 1.3$	$0.82 \pm 2$	$0.34 \pm 1.3$	0.5

**Table 2. Pre-and post-operative condition of involved eyes**

Characteristic	Disinsertion	Myectomy	Anterior transposition	P value
Preoperative esotropia	6	52	7	0.47
Preoperative exotropia	6	31	10	0.26
Preoperative hypotropia	1	2	1	0.46
Preoperative hypertropia	1	13	6	0.13
Postoperative hypertropia	1	5	3	0.3
Preoperative V-pattern	5	53	9	0.43
Postoperative V-pattern	0	7	3	0.27
Preoperative DVD	1	10	6	0.052
Postoperative DVD	0	6	2	0.5

DVD, dissociative vertical deviation

**Table 3. Comparison of mean change of IOOA between surgical treatment groups by follow-up periods**

	Disinsertion	Myectomy	Anterior transposition	P value
Preoperative	1.33±0.65	1.93±0.89	2.52±0.9	0.001
1 week	-1.25±0.45	-1.8±0.86	-2±0.84	0.03
3 months	-1.2±0.42	-1.8±0.9	-2±0.6	0.06
6 months (Last visit)	-1.15±0.37	-1.9±1	-2±0.01	0.15
Postoperative	0.1±0.3	0.12±0.4	0.62±0.7	0.001

IOOA, inferior oblique muscle overaction

**Table 4. Comparison of mean change of IOOA between surgical treatment groups by preoperative IOOA measures**

	Disinsertion	Myectomy	Anterior transposition	P value
+4	-	-4±0.01	-2±0.57	0.001
+3	-2±0.02	-2.7±0.45	-2.5±0.57	0.28
+2	-2±0.01	-1.9±0.3	-1.6±0.57	0.5
+1	-1±0.01	-0.9±0.38	-	0.6

IOOA, inferior oblique muscle overaction

surgical treatment groups and were not observed after operation. In the study by Min et al, hypotropia occurred in one eye out of 20 patients, however, in the present study no new patient with this condition was not detected, post operatively.<sup>[13]</sup> Moreover, in our study, residual hypertropia was observed in one patient with disinsertion, 5 patients in the myectomy and 3 patients in the anterior transposition groups but the difference was not significant between groups.

DVD improved in all three groups. There were no differences in pre- and post-operative DVD among the

groups. This result was comparable to the outcomes reported by Unâovská et al in which myectomy and anterior transposition were equally effective in treating DVD. Nevertheless, IOOA treatment was more effective by anterior transposition versus myectomy.<sup>[17]</sup> As in Nowakowska et al study in which V-pattern angle was reduced by bilateral IO surgery,<sup>[18]</sup> our study also showed that V-pattern was treated in the majority of patients. We just had 7 out of 53 eyes in myectomy group and 3 of out of 9 eyes in anterior transposition group with V-pattern, after the procedure. Although V-pattern remained in none of 5 patients in disinsertion group, this difference was not significant among the groups.

We observed few side-effects in surgical procedures. Underaction of IO muscle was detected in one eye in the disinsertion group, two eyes in the myectomy group and one eye in the anterior transposition group. The rate of IOUA in disinsertion, myectomy and anterior transposition procedures has been reported 4%, 14%, and 5%, respectively.<sup>[19]</sup> In another study, the rate of IOUA was reported to be 21%.<sup>[14]</sup> Bhatta et al IOUA observed IOUA in 35% of eyes with mild and persistent symptoms in the majority of patients.<sup>[20]</sup>

Although the degree of IOOA was different in the three groups in preoperative and first week follow-up examinations, this difference was not significant at three months and at last visit. As a result, the effects of disinsertion, myectomy and anterior transposition were equal in all patients at last visit. We conclude that all these three procedures are effective in the treatment of either primary or secondary IOOA in children and adults with minimum side effects.

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